

**From:** [Gerald Heston](#)  
**To:** [Richard Fetzner](#); [Kelley Chase](#)  
**Subject:** Fw: Trt of Manganese  
**Date:** 06/13/2012 08:31 AM

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FYI.

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----- Forwarded by Gerald Heston/R3/USEPA/US on 06/13/2012 08:30 AM -----

From: William Arguto/R3/USEPA/US  
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Date: 06/13/2012 07:55 AM  
Subject: Fw: Trt of Manganese

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Gerry;

Ellen had done some research on Mn treatment - see below. if you have any questions give us a call.

Bill

----- Forwarded by William Arguto/R3/USEPA/US on 06/13/2012 07:53 AM -----

From: Ellen Schmitt/R3/USEPA/US  
To: William Arguto/R3/USEPA/US@EPA, KarenD Johnson/R3/USEPA/US@EPA  
Cc: Victoria Binetti/R3/USEPA/US@EPA  
Date: 06/12/2012 10:00 AM  
Subject: Trt of Manganese

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Let me know if you would like me to look into this more.

I found no information on drinking water treatment for Mn on WCIT.

**Info found on the NSF website,  
[http://www.nsf.org/consumer/drinking\\_water/selecting\\_dwtu.asp](http://www.nsf.org/consumer/drinking_water/selecting_dwtu.asp) and  
might explain why the WaterMedic system includes chlorine.**

- *Oxidation / [Filtration](#) Systems*

*Excessive levels of iron and manganese can be treated through a process known as oxidation, which is then followed by [Filtration](#). An oxidizing agent such as chlorine or potassium permanganate is used to oxidize the iron or manganese to an insoluble*

form, which can then be filtered through a special media bed. The filter media bed must be backwashed and the oxidizing agent must be replenished regularly. These systems are generally large and designed to treat water for the whole house; they can also be used to treat hydrogen sulfide.

**From a USDA document called Engineering Tech Tips (Sept 1999),  
<http://www.fs.fed.us/eng/pubs/html/99711308/99711308.html>**

-Treatment options include sequestering, ion exchange, oxidizing filters, and oxidation and filtration or settling. The most appropriate and cost-effective option depends on the concentration and form of Fe/Mn, water chemistry, and how much water needs to be treated.

-Sequestering does not remove Fe/Mn from the water. Sequestration binds the Fe/Mn in soluble form preventing the compound from oxidizing on contact with air or chlorine. This is only an option if the iron is in the form of ferrous iron ( $\text{Fe}^{2+}$ ), manganese as manganous ( $\text{Mn}^{2+}$ ), and if the combined concentration is less than 1 to 3 mg/L. Sequestering prevents staining of plumbing fixtures and discoloration of the water, but a slight metallic taste remains. Sequestering agents break down at high temperatures found in water heaters.

-Sodium silicate and chlorine is effective to sequester iron, but is less effective for manganese. Sodium silicate does not break down as readily as phosphate compounds in hot water heaters.

#### - Ion Exchange

Ion exchange, such as salt-based water softeners, can remove small amounts of soluble iron and/or manganese from water. Potassium chloride may be used to regenerate the resin beads instead of sodium chloride if the added sodium is of concern. Water softeners are usually only considered if water hardness is also a problem, however, they should be considered when the combined iron and manganese is less than 2 to 5 mg/L. At higher concentrations, precipitated iron residue may buildup on the softening resin, decreasing the efficiency of the softener. Washing the resin with an acid or sodium bisulfate is necessary to remove the residue.

#### - Oxidizing Filters

Oxidizing filters can remove up to 15-25 mg/L of combined concentrations of Fe/Mn. Greensand, anthracite sand, natural or synthetic zeolites are used in a mixed media or a pressure filter. Potassium permanganate ( $\text{KMnO}_4$ ) is used to coat greensand and anthrasand with manganese oxide, giving it a catalytic effect. This coating oxidizes and removes Fe/Mn, usually without requiring an additional oxidation/precipitation step. The coating can be maintained either by a continuous potassium permanganate feed or by backwashing at set intervals with a potassium permanganate solution.

Natural and synthetic zeolite filter media have a catalytic effect that does not require chemical backwashing to remove the precipitate. The filter media may use venturi air injection as an oxidant, with an air relief valve that bleeds off excess air. The oxidation process is completed in the zeolite media filter, and the precipitate is filtered out. The filter is periodically backwashed to remove the

*precipitant.*

*Oxidizing filters can be used with ferrous or ferric iron, and manganous or manganic manganese. The minimum pH is 7.0. A pH of 8.0 is needed when the manganese concentration is high. Filtering over marble chips can raise the pH if needed. The rate of backwash is higher than for ion exchange, but unlike phosphate and sodium chloride potassium permanganate is not an environmental issue.*

*Tannins and hydrogen sulfides will foul the filter media, reducing efficiency. Oxidizing filters work best with water low in phosphate and organic material. Chlorine will adversely affect the catalytic property of the filter media, and should be added after filtration.*

#### - Oxidation and Filtration/Settling

*Oxidation is required before precipitation, settling and/or filtration. Soluble ferrous iron ( $\text{Fe}^{2+}$ ) is oxidized to a ferric iron ( $\text{Fe}^{3+}$ ), which readily forms the insoluble iron hydroxide complex  $\text{Fe}(\text{OH})_3$ . Manganous ( $\text{Mn}^{2+}$ ) is oxidized to manganic ( $\text{Mn}^{4+}$ ), which forms insoluble manganese dioxide ( $\text{MnO}_2$ ). The insoluble metals can be precipitated out in a settling tank or removed by filtration.*

*Aeration can be an effective, low-cost method of oxidation of iron. Water is passed down a series of porous trays by gravity to provide contact between air and water. Air stripping towers can also provide aeration. The water trickles down through a tower packed with an open plastic media while air is forced up through the media. Aeration towers also remove sulfides, radon, and volatile organic chemicals (VOCs). Venturi nozzles can be used to introduce air into the water. Aeration will not be as effective if iron bacteria or humic materials are present. The rate of reaction for manganese is very slow at pH values less than 9.5.*

*Chlorine is commonly used as an oxidant. Chlorine feed rate and contact time can be determined by simple jar tests. Trihalomethanes (THMs) may be a problem if organic material (VOCs, humic materials, etc.) is present in the water. The water will need to be monitored for chlorine residual content in the distribution system. Certified water treatment operators are required when chlorine is added to drinking water.*

*Potassium permanganate ( $\text{KMnO}_4$ ) is a very efficient oxidant of both iron and manganese. It is more expensive than chlorine, but capital equipment costs are usually less. The dose of potassium permanganate must be carefully controlled. Too little will not oxidize all the iron and manganese, too much will leave a pink tinge in the water.*

**Information from an article, written by the American Ground Water Trust  
- 2002  
<http://www.agwt.org/info/pdfs/manganeseproblems.pdf>**

Seems to provide similar information as the USDA document regarding drinking water treatment of Mn